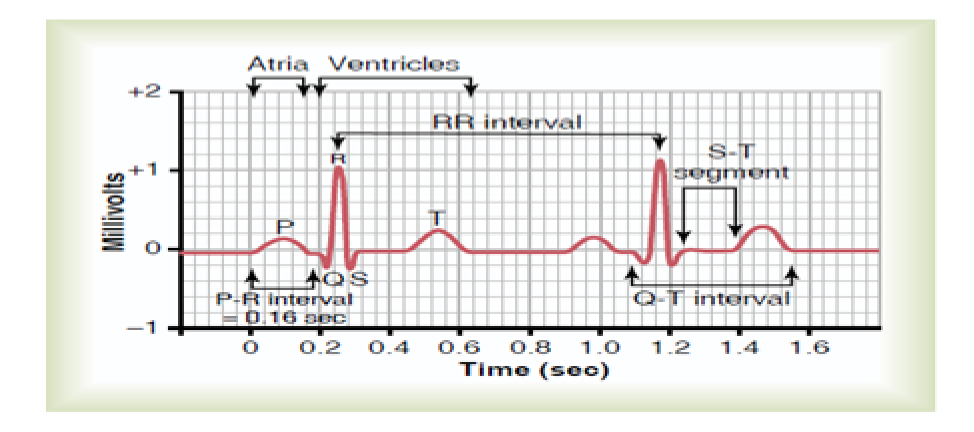


ELECTROCARDIOGRAM ECG

Electrocardiogram is related to electrical activity of the heart . If there is electrical activity in the heart, the electrical current can spread or travel to the tissues surrounding the heart and small portion of these current can reach the surface of the body. And, If we put two electrodes of a recording method in the opposite side over the heart on the inferior surface of the chest, the electrical potential generated by these current can be recorded. These recording we called it electrocardiogram or ECG.



In normal ECG there are P wave , QRS complex and T wave.

* The P wave is caused by the depolarization of the atria.

* The QRS complex is caused by the depolarization of the ventricles.

* The T wave is caused by repolarization of ventricles.

* The atrial repolarization is absent here, why ? Because atrial repolarization occurs at the moment when QRS is recorded so the large QRS wave obscure the atrial repolarization.

There are also some normal intervals.

* The P-R intervals from the beginning of the P wave to the beginning of the QRS complex. It is the interval of time between beginning of the depolarization of the atria and beginning the depolarization of ventricles = 0.16 seconds.

* The Q-T interval from the beginning of the QRS wave to the end of the T wave. This interval normally equals 0.35 seconds. Contraction of the ventricles lasts this interval.

* The S-T segment from the end of S wave to the beginning of T wave , during this segment all the ventricular muscle fibers are completely depolarized so the segment is isoelectric, There is no potential difference. Normally, it is isoelectric, any upward or downward deviation of this segment indicates myocardial damage.

In the paper of ECG, there are smaller squares and large squares.

The smaller squares are nearly 1 millimeter diameter, horizontally they indicate time in seconds and it equals 0.04 seconds per square, and vertically indicate voltage in millivolts which equals 0.1 millivolt per square.

The normal heart rate is the normal rate of the SA node discharge which is 70-80 per minute, the average is 72.

The heart rate “HR” can be obtained from the ECG :

1) HR= 60/ the interval between 2 successive R waves.

Normally, HR = 60/0.83 = 72 and if it is 0,8 we will obtain 75 beat per minute.

2) HR =1500/the no. of squares between the interval between 2 successive R waves.

Normally, the number of small squares is 20. HR = 1500/20= 75 beat per minute.

In this figure, Recording the depolarization wave (A and B) and the

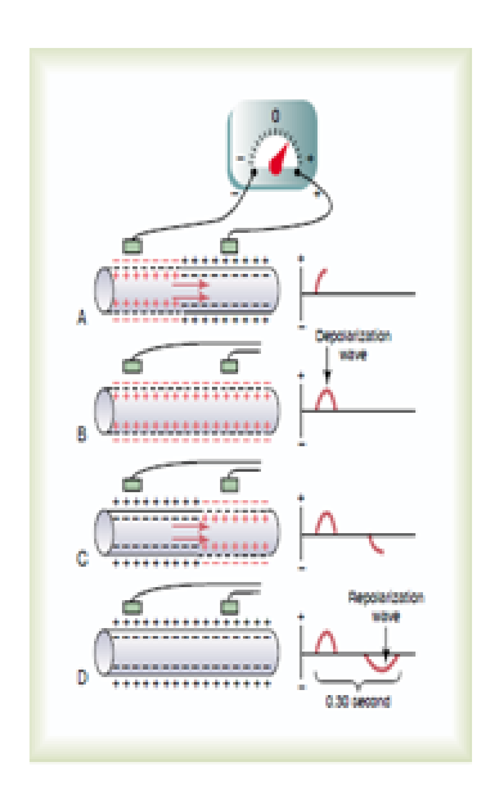
repolarization wave (C and D) from a cardiac muscle fiber.

* In the figure A, The fiber is half way depolarized. The negative electrode is connected to the negative side and the positive electrode connected to the positive side. In this case, we see maximum positive record.

* In the figure B, the fiber is completely depolarized. The two electrodes are in areas of equal negativity, so there is no potential difference, so the potential returns to zero line.

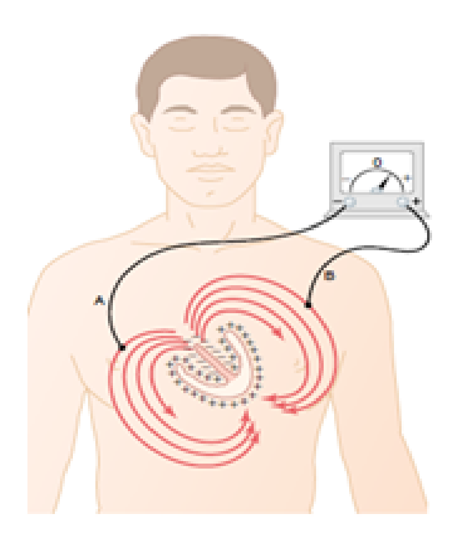
* In figure C, the fiber is half way repolarized. The negative electrode is on the positive side and the positive electrode is on the negative side, so the recording in this case is negative.

* In the last fiber, the electrodes are in areas of equal positivity, so no potential difference, so the potential returns to the zero level.



Since purkinji fibers divide into right and left bundle branches which pass in the septum toward the apex and divide to smaller branches which spread around the ventricular champers downward, Cardiac impulse pass in the ventricular septum and spread into the inside surfaces of the ventricles “endocardial surface”. This provides electro negativity in the inside of the ventricles and electro positivity in outer walls , the place which was depolarized has electro negativity and the one which is not depolarized has electro positivity.

During most of depolarization process of the ventricles, electronegativity occurs toward the base of the ventricles and electro positivity toward the apex of the ventricles. In other words, during most of the depolarization process the average direction of current flow “electronegitivity” occurs toward the base and electro positivity toward the apex of the depolarization process, but near the end of depolarization or immediately before the end this average direction reverses ,so electropositivity toward the base and electronegativity toward the apex for 0.01 seconds.

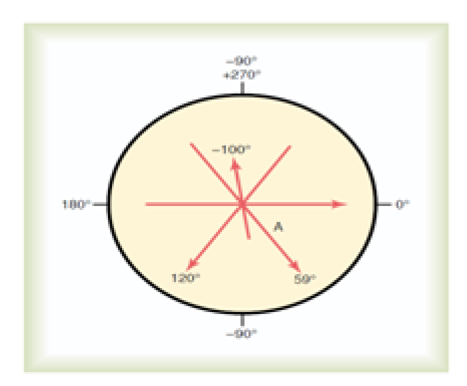


The VECTOR is an arrow that points in the direction of electrical potential generated by electrical current with the arrow head in the positive direction and the length of arrow is proportional to the

voltage of the potential.

For example, the arrow is small if voltage is less. The direction of vectors is described in term of degrees ,i.e. when the vector is horizontal from right to left, this vector = 0° and if it is horizontal form left to the right, it is 180° . If it is vertical from above down wards, it = +90° degree and if it is vertical form down upwards, it = -90°. The state of the vector rotates clock wise.The normal mean QRS vector or mean electrical

axis of the ventricles is in the direction of +59°. During most of depolarization process, the apex of the heart is positive with respect to the base.



Sometimes there are normal variations, i.e. more or less than +59°. Due to anatomical differences in purkinji fibers distribution or anatomical differences in the musculature of different parts of heart (different ventricles). In some cases, there may be change or deviation of this axis in the vector. For example, there is axis deviation to the left in obese (fat) people due to excess of visceral adiposity that make pressure on the diaphragm ,and a right axis deviation in tall and thin people.

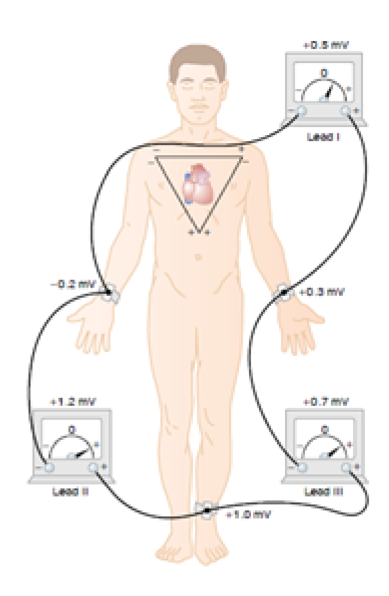
The STANDARD THREE POLAR LIMB LEADS. The triangle in the figure is called EINTHOVEN'S TRIANGLE and in the middle of the triangle is the heart. The upper two points of the triangle represent the points of two arms which are electrically connected with the fluid

surrounding the heart and the lower point (head of triangle) represents the point of the left leg which is electrically connected with the fluid surrounding the heart. Here we have three leads I, II and III.

In lead I, which equal nearly +0.5 millivolt, the negative electrode is connected to the right arm and the positive electrode is connected to the left arm.

In lead II, the negative electrode is connected to right arm and the positive is connected to the left leg. The recording is +1.2 millivolt.

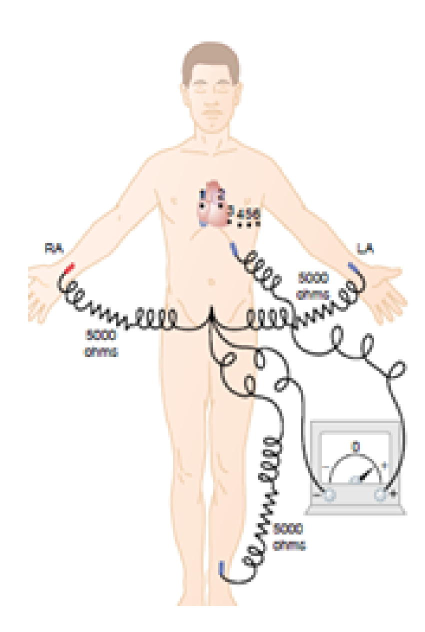
In lead III, the negative electrode is connected to left arm and positive electrode is connected to the left leg and the recording is +0.7 milivolt.



This is the chest leads, in which the negative electrode of the ECG is connected through electrical resistance to the right arm, left arm and left leg and the positive electrode is connected to places over the heart in the anterior surface of the chest at six separated points v1, v2, v3, v4, v5 and v6.

ECG of the chest leads the v1 and v2 give mainly negative record, why?

The positive recording electrodes in v1+2 are placed near to the base of the heart which is the direction of electro negativity, while v4+5+6 the positive electrode is near the apex.



Other recording method is called the AUGMENTED UNIPOLAR LIMB LEADS. Two of the leads are connected through electrical resistance to the negative electrode and positive electrode is put on the third limb.

When the positive electrode on the right arm it is called aVR lead.

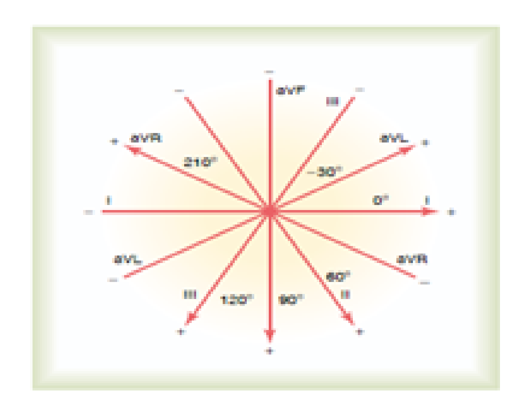
When it is on the left arm it is called aVL.

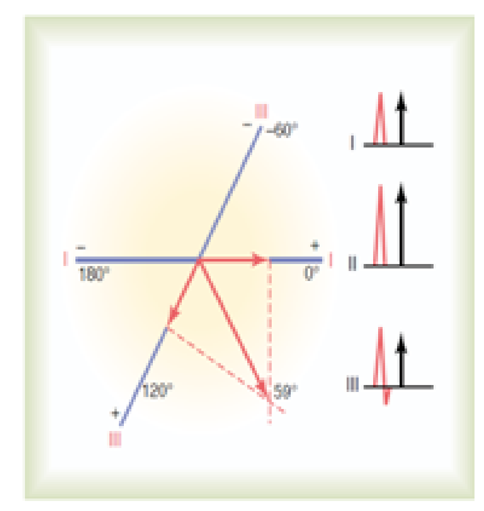
When it is on the left leg it is called aVF.

The aVR record is negative because the voltage of right arm measures -0.2 millivolt with respect to the average so the aVR is negative.

Here the vectors of all lead 1 and lead 2 and lead 3 and aVR,

aVL a,VF. Axis of different leads or vectors of different leads.





In the practical aspect, when we want to make a vector of this leads. we have three standard leads and we have their ECG and we want to know what is the vector of or electrical axis of the ventricles at this moment. Here we have lead I , lead II and lead III in the ECG and the axes of the lead I and lead III.

1. We measure the voltage of lead I with ruler.

2.In lead III, there is positive and negative recording, so we subtract negative from positive.

3. Then we draw perpendicular lines at the end of the lead that we’ve measured.

4.The point of intersection between two perpendicular lines is the arrow’s head or the head of the vector.

5. Then we draw a line to measure the degree which = +59° normally

(NOTE : watch videos about this to understand it properly or pay attention during lecture and practical seminar ^_^)

If there is cardiac hypertrophy, axis deviate to the left or the right.If there is hypertrophy of one ventricle, axis deviates toward the hypertrophied ventricle because the hypertrophied ventricle has a greater amount of muscle, so more time is required for the depolarization to pass through this hypertrophied ventricle, so the normal ventricle will depolarize long before the hypertrophied ventricle, which means that the direction of electro negativity is toward the normal and the electro positivity will be in direction of the hypertrophied ventricle.

In the case of left axis deviation, it will be nearly -15° to the hypertrophied ventricle. In the hypertrophy of right ventricle, the right axis deviation occur nearly +170°.

There is another pathologic condition that cause deviation of mean ventricular axis, which is bundle branch block. In this case, the normal ventricle will also depolarize long before the other abnormal ventricle. The direction of the deviation is the same of the direction of the block. So in the left branch block, the deviation of the axis occur to the left nearly in direction of -50°,and in the right bundle branch block, there will be right axis deviation nearly in direction of +105° .

For more information and figures look at Guyton chapter 11 and 12.

SHARE AND CARE 39

هذا عمل طلابي قد لايخلو من الخطأ فالرجاء اعلامنا في حالة وجود خطأ لتصحيحة . بالتوفيق